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1402

INSTRUCTIONS AND APPLICATIONS

Random Noise Generator Type 1402

Random noise with uniform spectrum density in the range 20—20ooo Hz (c/s).
Symmetrical Gaussian distribution up to 4 σ.
Built-in r.m.s. output voltmeter with selectable averaging times.
Built-in —3 dB/octave weighting network.
Provision for connection of external filters, making narrow band output signal possible.

Accelerometers
Acoustic Standing Wave Apparatus
Artificial Ears
Artificial Voices
Audio Frequency Response Tracers
Audio Frequency Spectrometers
Audio Frequency Vacuum-Tube Voltmeters
Automatic A. F. Response and Spectrum Recorders
Automatic Vibration-Exciter Control Generators
Band-Pass Filter Sets
Beat Frequency Oscillators
Complex Modulus Apparatus
Condenser Microphones
Deviation Bridges
Distortion Measuring Bridges
Frequency Analyzers
Frequency Measuring Bridges
Hearing Aid Test Apparatus
Heterodyne Voltmeters
Level Recorders
Megohmmeters
Microphone Accessories
Microphone Amplifiers
Microphone Calibration Apparatus
Mobile Laboratories
Noise Generators
Noise Limit Indicators
Pistonphones
Polar Diagram Recorders
Preamplifiers
Precision Sound Level Meters
Recording Paper
Strain Gage Apparatus and Accessories
Surface Roughness Meters
Variable Frequency Rejection Filters
VHF-Converters
Vibration Pick-ups
Vibration Pick-up Preamplifiers
Wide Range Vacuum Tube Voltmeters

BRÜEL & KJÆR

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Random Noise Generator

Type 1402 H

s/n. 5771

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1. Introduction

In acoustic, mechanical, and electronic research various types of noise are used as signal sources. A noise type on which several other types are based, is the so called Gaussian random noise displaying a uniform spectrum density (also termed "white" Gaussian random noise). By filtering this noise in different filters, shaped noise can be obtained. When filtered by band-pass filters, narrow bands of noise can be supplied. The B & K Random Noise Generator produces a Gaussian random noise signal with a uniform spectrum density, and, in conjunction with the B & K filters, the other useful types of noise signals can be obtained.
Below are given the definitions and some comments on various noise types.

Random Noise.

Random noise is defined as a signal, the instantaneous magnitude of which is not specified for any given instant of time. The instantaneous magnitudes of random noise are specified only by probability distribution functions which

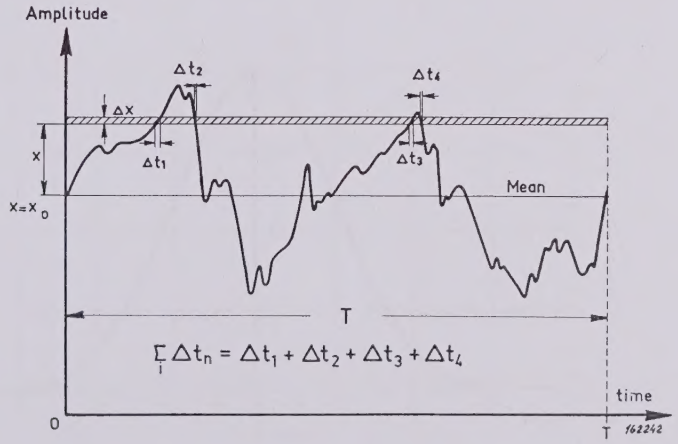


Fig. 1.1. Schematic illustration of probability.

give the fraction Δt of the total time T that the magnitude x, or some sequence of magnitudes, lies within a specified range $(x + \Delta x) - x$, see Fig. 1.1. The time fraction, during which instantaneous magnitudes are present within x and $x + \Delta x$, is seen to be:

$$\Sigma t_n = \Delta t_1 + \Delta t_2 + \Delta t_3 + \Delta t_4$$

The probability P, that instantaneous magnitudes are present within the voltage limits x and $x + \Delta x$, will then be:

$$P\,(x, x + \Delta x) = \frac{\Sigma\, t_n}{T}$$

The probability is a dimensionless quantity which is independent of time, provided the time T is long enough to allow a practically "infinite" number of events to happen.
Since the magnitude of the signal is statistically distributed, it is convenient to introduce the concept of probability density ("amplitude density"). This gives the picture of the distribution of the instantaneous magnitude in the signal, because the magnitudes occur with a certain "density" when the phenomenon is studied over a period of time. From the probability $P\,(x, x + \Delta x)$ the probability density $p\,(x)$ can be derived:

$$p(x) = \lim_{\Delta x \to 0} \frac{P\,(x, x + \Delta x)}{\Delta x}$$

By varying the value x from $-\infty$ to $+\infty$ and plotting $p\,(x)$ as a function of x, the probability density curve for the signal in question is found

Gaussian Random Noise.
This is a random noise signal, the magnitudes of which are distributed according to the Gaussian (normal) distribution function. The Gaussian distribution is based on an infinite number of events which have no correlation.

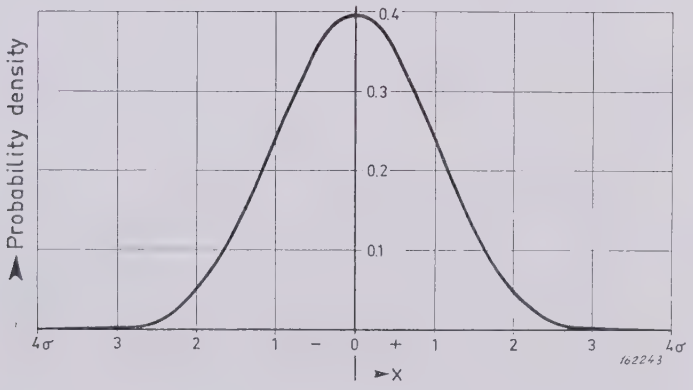


Fig. 1.2. Theoretical and normalized Gaussian probability density curve.

When the magnitudes in a noise signal are distributed in accordance with a Gaussian function, the probability density function $p\,(x)$ will be:

$$p(x) = \frac{1}{\sigma \sqrt{2\,\pi}} \cdot e^{-\frac{x^2}{2\,\sigma^2}}$$

where σ is the standard deviation which equals the r.m.s. value of the noise signal. For the case $\sigma = 1$:

$$p(x) = \frac{1}{\sqrt{2\pi}} e^{-\frac{x^2}{2}}$$

From this function the Gaussian probability density curve, illustrated in Fig. 1.2, is plotted.

When the density curve is reproduced in a graph with logarithmic ordinate $p(x)$ the response will be similar to that shown in Fig. 1.3. From

$$\log p(x) = \log \frac{1}{\sqrt{2\pi}} - \frac{x^2}{2} \log e. = k_1 - k_2 x^2$$

it is seen that the curve will be represented by a parabola.

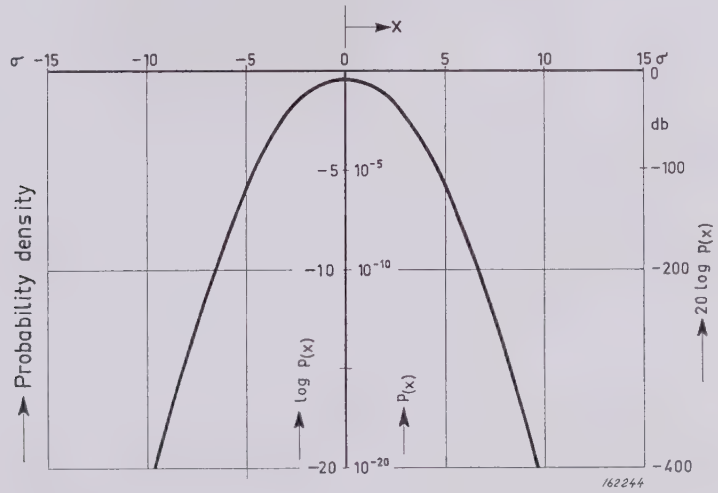


Fig. 1.3. Theoretical and normalized Gaussian probability density curve. Plotted from log p(x) with linear abscissa.

Gaussian Random Noise with Uniform Spectrum Density.

This type of noise signal is a Gaussian random noise signal, the frequency spectrum of which is continuous and uniform, thus containing equal power per cycle bandwidth in the band considered.

Fig. 1.4 illustrates the correlation between the magnitudes of Gaussian random noise and the Gaussian probability density curve.

A noise signal, which has a uniform spectrum density and is normally distributed will in many cases simulate the excitation that would be expected in environments determined by the laws of nature. It is therefore a powerful tool in research and development. However, even if the excitation of test objects by a wide band of noise may give much useful information, the noise signal is often required in narrower bands. Measuring equipment designed to

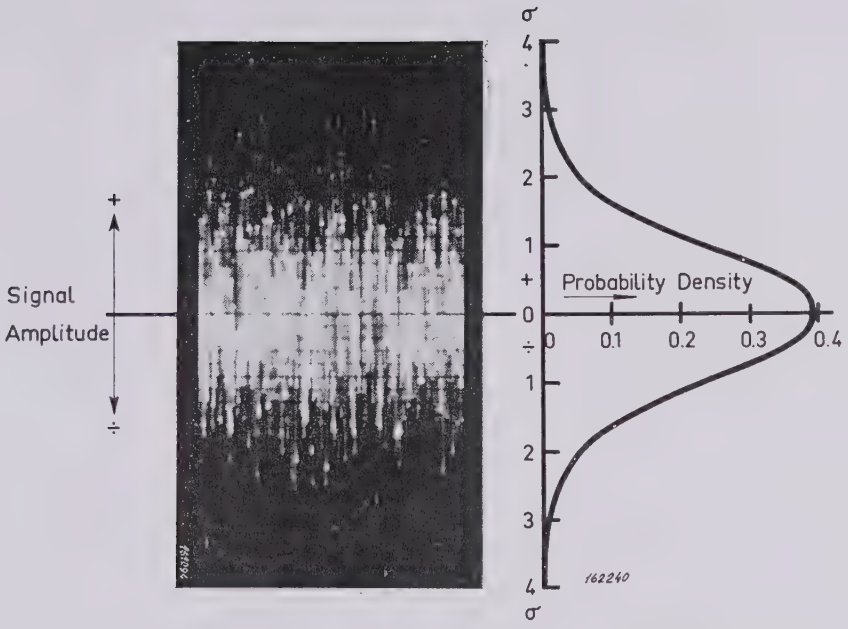


Fig. 1.4. Correlation between th emagnitudes in a Gaussian random noise signal and the Gaussian distribution curve.

handle noise will therefore, besides the Noise Generator, often include a set of band-pass filters. The B & K Band-Pass Filter Set Type 1612 is excellent for this purpose.

Constant-Relative-Bandwidth Filtered Noise.

When band-pass filters displaying constant relative bandwidth are used in conjunction with noise having uniform spectrum density the increasing noise power for increasing filter centre frequency should be taken into account.
In uniform spectrum density noise, the noise power W is proportional to the noise bandwidth Δf (in cycles per second)

$$W = a_1 \Delta f$$

a_1 = constant.
In terms of the r.m.s. voltage level V of this noise ,the relationship will be:

$$V = a_2 \sqrt{\Delta f}$$

a_2 = constant.
That is to say, the voltage level V is proportional to the square root of the noise bandwidth Δf in cycles per second.
As the bandwidth Δf of filters with constant relative bandwidth is pro portional to the filter centre frequency f_o, i.e. $f_o = a_3 . \Delta f$. The noise out put voltage from such a filter will be:

$$V = a_2 \sqrt{\frac{f_o}{a_3}} = a_4 \sqrt{f_o}$$

The increase in noise voltage per decade increase in frequency can be derived from:

$$\frac{V''}{V'} = \frac{a_4}{a_4}\sqrt{\frac{10\,f_o'}{f_o'}} = \sqrt{10}$$

Here V' is the voltage at a specified frequency f_o', and V'' the voltage at a frequency decade $10 \times f_o'$ higher.
This voltage increase expressed in dB is:

$$20 \log \sqrt{10} = 10 \text{ dB}$$

If the frequency increases by one octave, the corresponding expression for the noise voltage increase in dB is:

$$20 \log \sqrt{2} \cong 3.010 \text{ dB}$$

i.e. 10 dB/decade $\cong$ 3 dB/octave.

Additional Brüel & Kjær literature, Technical Reviews:
Amplitude Density Curves, No. 4 - 1959
Recording of Narrow Band Noise, No. 4 - 1960
The Application and Generation of Audio Frequency Random Noise, No. 2 - 1961.

2. Description

General.

The Noise Generator Type 1402 produces a noise signal with uniform spectrum density in the frequency range 20—20ooo Hz (c/s) with a true Gaussian (normal) amplitude distribution. If the B & K Band-Pass Filter Set Type 1612 is inserted between the amplifier sections of the Generator, noise in

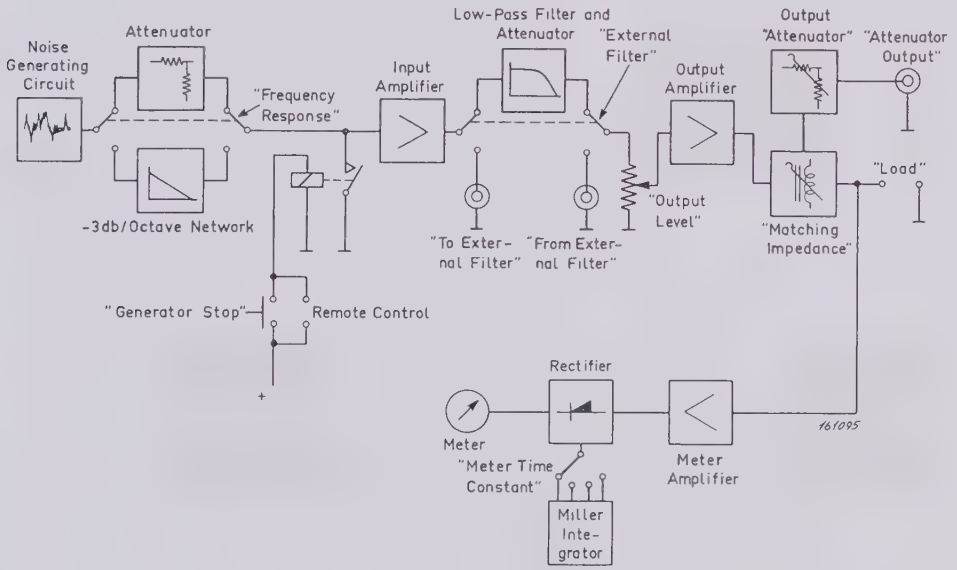


Fig. 2.1. Block diagram of Random Noise Generator.

⅓ octave bands or 1/1 octave bands will be available at the output. By using other types of external filters, any desired type of "shaped" noise or bands of noise can be obtained. The spectrum density characteristic of the Generator can also be weighted by a built-in filter, having a decreasing characteristic of 3 dB per octave. This secures a constant r.m.s. output level in cases where the external filter set has constant relative bandwidths. The r.m.s. value of the output signal is displayed on an indicating instrument that can be switched to measure with various averaging times (time constants). The output signal can be continuously varied and is available from an output transformer, giving various output impedances, or from a calibrated step attenuator. Great efforts have been made to ensure that the amplitude

distribution curve of the noise signal is symmetrical. In addition, the hum level of the Generator has been effectively suppressed. This allows even a very narrow band of noise with a centre frequency equal to the line frequency to be of a true Gaussian character.
The Noise Generator is made up of a special noise generating circuit, a 3 dB/octave weighting network, an input amplifier, an output amplifier, and a special indicating meter arrangement. Refer also to the block diagram in Fig. 2.1.

Noise Generating Circuit.

The noise generating circuit is a special B & K design, using two zener diodes as the primary noise source. (See Fig. 2.2). The diodes are subjected to a stabilized d.c. current of such a magnitude that the diodes work at the

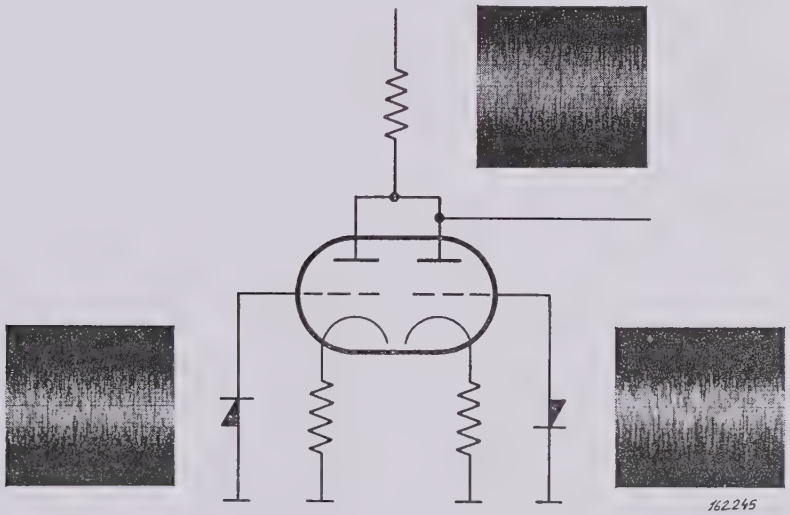


Fig. 2.2. Schematic illustration of the primary noise source arrangement.

point on the characteristic which gives the highest noise voltage. The a.c. component of this noise voltage is fed to an amplifier, one for each diode. By adding these two signals a noise signal with a symmetrical Gaussian amplitude distribution is obtained.
The output signal from the noise generating circuit can be applied directly to the input amplifier, thereby producing a constant power density spectrum, or it can be applied to a built-in weighting network decreasing the spectrum characteristic by 10 dB/decade $\simeq$ 3 dB/octave.

3 dB/Octave Weighting Network.

This network is particularly valuable in cases where narrow bands of the noise signal are selected by a set of filters having a constant relative band-

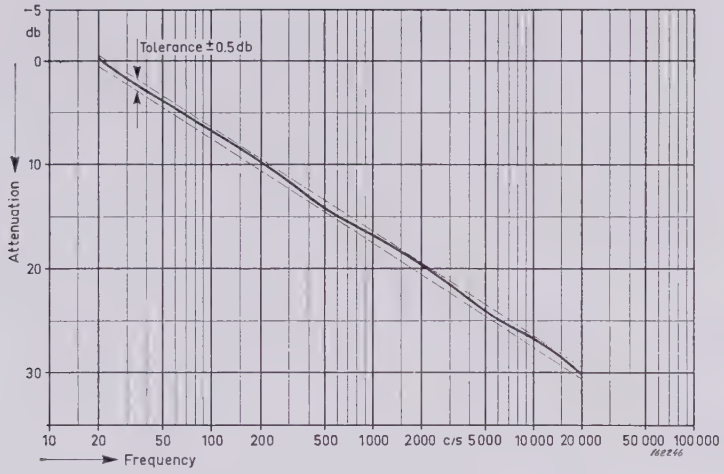


Fig. 2.3. Amplitude vs. frequency characteristic of 3 dB/octave network as measured by a sine-wave signal.

width. The weighting network will then compensate for the 3 dB per octave increase in voltage level, which will occur as the noise voltage level increases with the square root of the bandwidth.

Principle. The desired characteristic is obtained by loading the signal generating circuit with a R-C network, the impedance of which decreases as a function of frequency by 3 dB/octave.

Fig. 2.3 shows the resultant characteristics as measured for a sine-wave signal. It is seen that the slope is made up of line portions derived from the individual R and C components.

The 3 dB/octave network is switched in and out of circuit by operating the knob FREQUENCY RESPONSE. An attenuator, combined with this switch, compensates for the initial voltage drop which occurs on switching in the 3 dB/octave network. The signal from this attenuator is then applied to the input amplifier.

Input Amplifier.

The input amplifier contains three stages with a large amount of negative feedback, which ensures stable amplification and low distortion. The last stage of the input amplifier is a cathode follower, which brings the output impedance of the input amplifier down to approximately 10 Ω. The output can be switched either to the terminal TO EXTERNAL FILTER or to the output amplifier, via a low pass filter with a cut-off frequency of 20 kHz (kc/s).

Generator Stop. A built-in relay can provide noiseless interruption of the Generator output signal by grounding the input of the input amplifier. This relay is energised internally, so it can be operated by a simple make contact

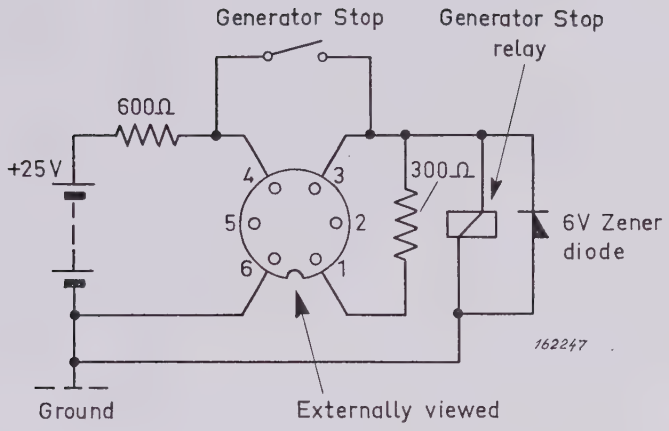


Fig. 2.4. Internal connections to REMOTE CONTROL jack.

in a remote control circuit, as well as by the GENERATOR STOP button. The REMOTE CONTROL connection, if required, must be made to the relevant jack on the instrument front panel. Fig. 2.4 shows a schematic diagram of the internal connections to this jack.
When the Noise Generator is used in, for example, automatic reverberation measurements the Generator Stop arrangement is remotely controlled (see also Figs. 6.1 and 6.2).

External Filter Connection.

The Noise Generator has terminals which allow external filters to be inserted between the input and output amplifiers. The impedances and voltage levels at the terminals are so chosen that they match the B & K Band-Pass Filter Set Type 1612*). By employing this Filter Set noise bands of ⅓ or 1/1 octave width can be selected. When filters of other manufacture are used appropriate precautions must be taken to ensure correct matching, remebering also that approximately 75 V d.c. is present at the terminal TO EXTERNAL FILTER.
When the external filters are not required, they can simply be disconnected by setting the switch EXTERNAL FILTER to position "Out". In this position of the switch, an attenuator, which gives an attenuation of approximately 20 dB and a low pass filter with a cut-off of 20 kHz (kc/s), are switched in between the input amplifier and the output amplifier. The signal level at the input of the output amplifier will, in this condition and for linear operation of the Generator, be of the same order as the level for —3 dB/octave weighted 1/1 octave noise bands. The level is approximately 5 dB higher for the ⅓ octave bands.

*) The previous type of Band-Pass Filter Sets, viz. the Type 1611 and Type 1610 can also be used.

Output Amplifier.

The Output Amplifier comprises an input potentiometer, an amplifier section, an output transformer, and a calibrated output attenuator.

"Output Level" Potentiometer. This is a continuously variable and linear potentiometer, providing adjustment of the output level of the Noise Generator.

Amplifier Section. This contains two stages, the large amount of negative feedback of which ensures low distortion and stable amplification. The feedback is taken from the output transformer, thus including this in the feedback loop. The maximum voltage amplification of the output amplifier is approximately 55 dB with the OUTPUT LEVEL potentiometer on "10" (max). The maximum peak output voltage that the output amplifier can handle without clipping is 170 V, and the maximum r.m.s. voltage is 40 V (see also paragraph "Clipping" on page 18).

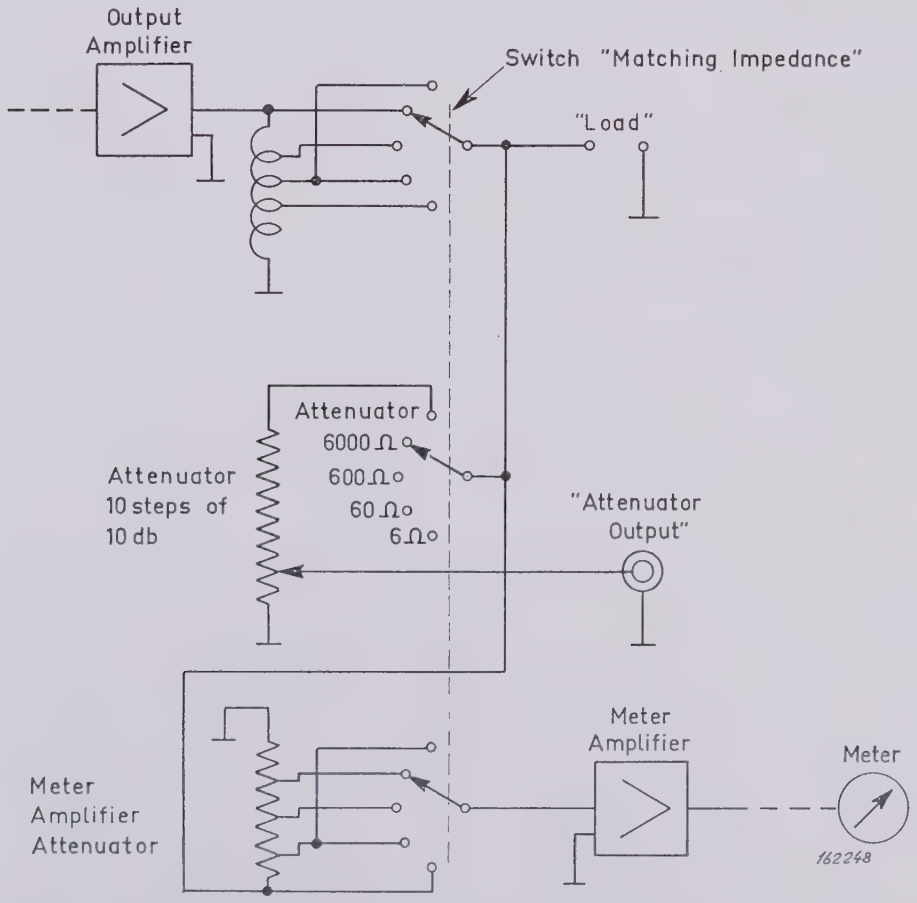


Fig. 2.5. Schematic diagram of the Noise Generator's output circuitry.

Output Transformer, is an auto-transformer intended for matching loads of 6 Ω, 60 Ω 600 Ω and 6ooo Ω. The actual output impedances are about, 10—20 % of the indicated values, but by loading the Generator with the stated impedance values an optimum of low distortion and output power is obtained. The various output impedances can be selected by a switch MATCHING IMPEDANCE.

The maximum undistorted power which can be supplied from the output terminal set LOAD is approximately o.25 Watt. This is obtained by full indicating meter deflection and with a load equal to the respective Matching Impedances. The instantaneous output power, derived from the peaks (4 σ), will be $0.25 \times 4^2 = 4$ Watts.

The output transformer is protected against overload from high input signals by a V.D.R. (Voltage Dependent Resistor) connected across the transformer winding which depresses voltage peaks higher than 350 V.

Calibrated Output Attenuator. A special position of the MATCHING IMPEDANCE switch, indicated "Attenuator", directs the output signal to a calibrated attenuator divided into 10 steps of 10 dB. Refer also to Fig. 2.5. The signal is in this case taken from the "60 Ω" tap of the output transformer, which means that the maximum available signal level from the terminal ATTENUATOR OUTPUT will be 4 V r.m.s. at full deflection on the indicating meter. When the attenuator is set to full attenuation, the minimum r.m.s. voltage at full deflection will consequently be 100 dB lower, i.e. 40 μV. The attenuator is designed to constitute an equivalent output impedance of approximately 50 Ω, independent of the attenuator setting.

Meter Amplifier.

A separate amplifier is provided for the meter circuit. On the input of the meter amplifier is an attenuator, which is combined mechanically with the MATCHING IMPEDANCE switch, and thus has the same number of steps. The attenuator ensures that the voltage to the meter amplifier is independent of the position of the MATCHING IMPEDANCE, i.e. maximum deflection on the indicating meter is always obtained for maximum output level in any position of the MATCHING IMPEDANCE Selector. The input of the attenuator is connected either to the terminal set LOAD or to the calibrated output ATTENUATOR as required. (Refer also to Fig. 2.5).

The meter amplifier has two stages and is designed as a balanced network in order to achieve a symmetrical output to the meter circuit. The second stage of the amplifier is a cathode follower, ensuring the low output impedance necessary for the meter circuit.

Meter Circuit.

The meter circuit is made up of an r.m.s. rectifier with full-wave rectification, a Miller integrator, and an indicating meter.

R.M.S. Rectifier. This rectifier is so designed that it will supply a rectified

voltage to the indicating meter proportional to the r.m.s. value of the noise signal. The meter will thus always show the r.m.s. level of the complete noise. If the rectifier is supplied with a sine-wave, the true r.m.s. value of this signal will also be read on the indicating meter. A simplified diagram of the combined rectifier and meter circuit can be seen in Fig. 2.6.
The voltage scale on the indicating meter will be linear except very close to the zero point where the initial part of the diode characteristic is perceptible.
A more detailed discourse on this type of meter rectifier can, if required, be found in the B & K Technical Review, No. 3 - 1958.

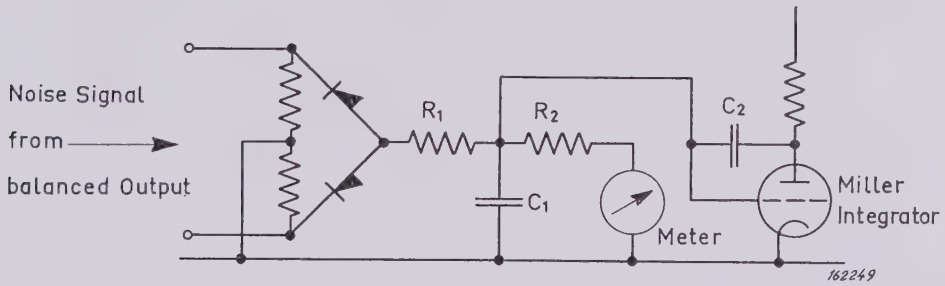


Fig. 2.6. Schematic diagram of rectifier circuit and associated Miller integrator.

Miller Integrator. When bands of noise are utilized the fluctuation frequencies present will cover the range from zero to a frequency equal to that of the bandwidth. If the noise band is made narrow, the low-frequency fluctuations will be perceptible as their contribution to the fluctuation power will now be relatively large. The value of the capacitor C_1 in the r.m.s. rectifier circuit, then has to be increased to avoid fluctuations of the indicating meter pointer and to ensure correct r.m.s. detection. To increase the capacitance a Miller Integrator is utilized, which has the effect of electronically enlarging the influence of a capacitor inserted in its circuit. The Miller Integrator is provided with a cathode follower to obtain a sufficiently low output impedance. The value of C_1 in the rectifier circuit is altered by changing the value of C_2, the various values of which are chosen by the switch METER TIME CONSTANT. The arrangement of different meter time constants is of great advantage, as an unnecessary high value of the capacitor C_1 results in an inconveniently high time constant (damping) of the indicating meter circuit. By the meter time constant is meant here the time it takes, from disconnecting the signal, for the meter pointer to fall to ⅓ of the deflection. Four values of the time constant 0.5, 1.5, 5 and 15 sec. can be selected.
Indicating Meter. This moving coil instrument, fully protected against overload, has a sensitivity of approximately 40 μA for full scale deflection. To obtain a reading without parallex error, the scale is mirrored.
The meter is provided with two linear voltage scales, and one dB scale, all illuminated by a built-in pilot lamp.

Noise Generator Overall Performance.

Frequency Response.

Fig. 2.7 shows a typical magnitude vs. frequency spectrum of the Noise Generator output when analyzed with a constant absolute bandwidth analyzer. The switch of the Noise Generator FREQUENCY RESPONSE was set in position "Linear, 20—20ooo c/s" and the EXTERNAL FILTER selector on "Out". The analyzer was a heterodyne wave analyzer set to a constant absolute bandwidth of 8 Hz (c/s). The output signal of the analyzer was recorded by the B & K Level Recorder Type 2305. From the spectrum it can be seen that the noise signal has a constant power per unit bandwidth throughout the complete frequency range.

When the output signal of the Noise Generator is analyzed by an analyzer passing constant relative bandwidth, a characteristic as shown in Fig. 2.8 will be obtained. The analyzer was in this case the B & K AF Spectrometer Type 2112. In the figure a typical characteristic is reproduced showing clearly the amplitude increase of 3 dB/octave, which will occur by using filters with constant relative bandwidths.

When the B & K Band-Pass Filter Type 1612 (constant relative bandwidth) is connected to the terminals TO EXTERNAL FILTER and FROM EXTERNAL FILTER (EXTERNAL FILTER to position "In"), and the noise is weighted by —3 dB/octave (FREQUENCY RESPONSE on "Weighted —3 dB/octave") a resultant spectrum, as illustrated in Fig. 2.9, will be achieved. In this case the Level Recorder has recorded the output signal from the Noise Generator. It will be seen that the output signal from the Noise Generator is now linear with frequency similar to the case where the unweighted signal was analyzed by a filter with constant absolute bandwidth.

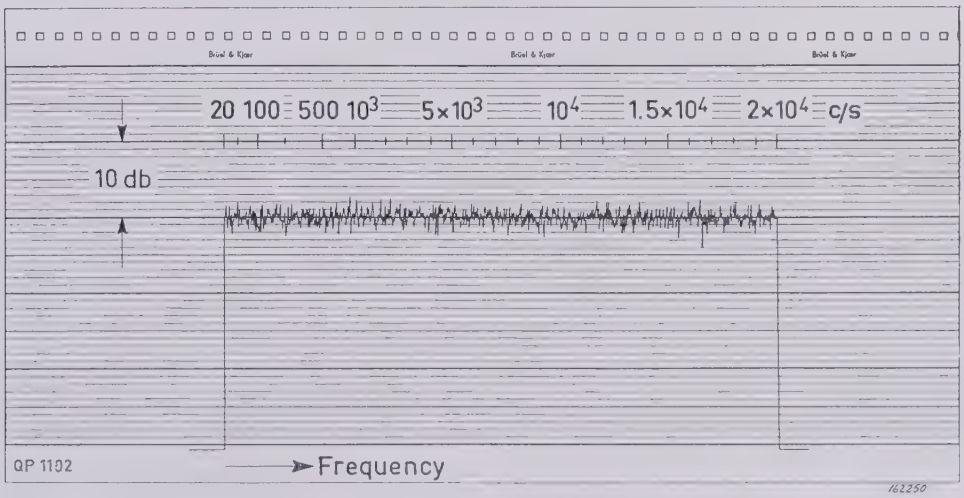


Fig. 2.7. Typical spectrum of the Noise Generator when measured by a constant bandwidth, 8 Hz (c/s), analyzer and recorded by the B & K Level Recorder Type 2305.

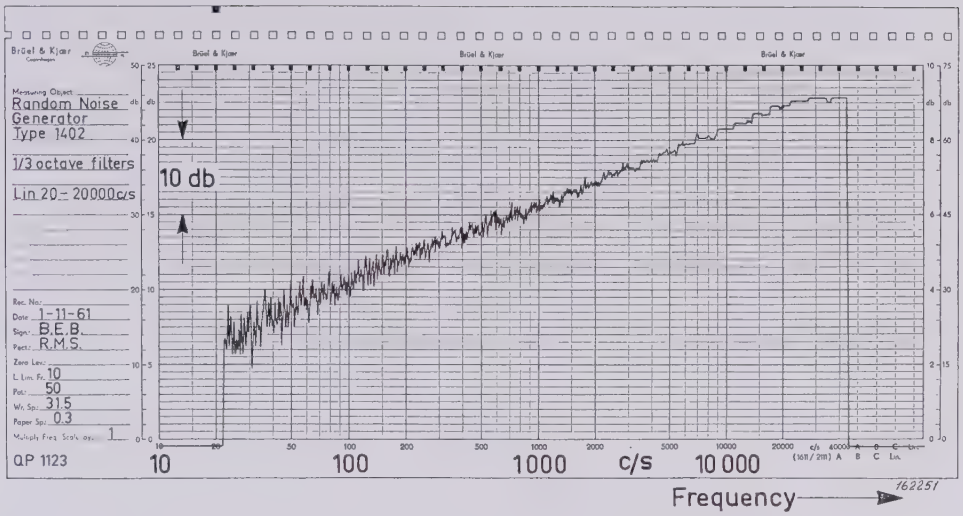


Fig. 2.8. Typical spectrum of the Noise Generator when measured by constant relative bandwidth filters (B & K A.F. Spectrometer Type 2112, 1/3 octave) and recorded on the B & K Level Recorder Type 2305.

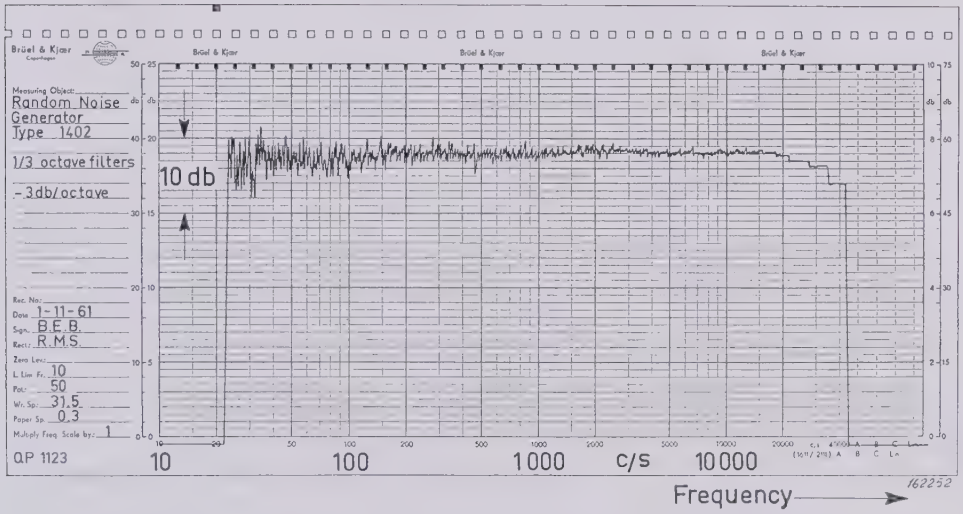


Fig. 2.9. Typical output spectrum of Noise Generator when used in condition "— 3 dB/Octave" and with Band-Pass Filter Set Type 1612 inserted.

Amplitude Distribution.

As previously mentioned, the amplitude density of the Generator output signal is normally (Gaussian) distributed for signals within $4 \times \sigma^*$) at full indicating meter deflection. If the noise source of the Generator had been designed to contain one diode only, the amplitude distribution of the output

*) σ is equal to the r.m.s. value of the noise signal.

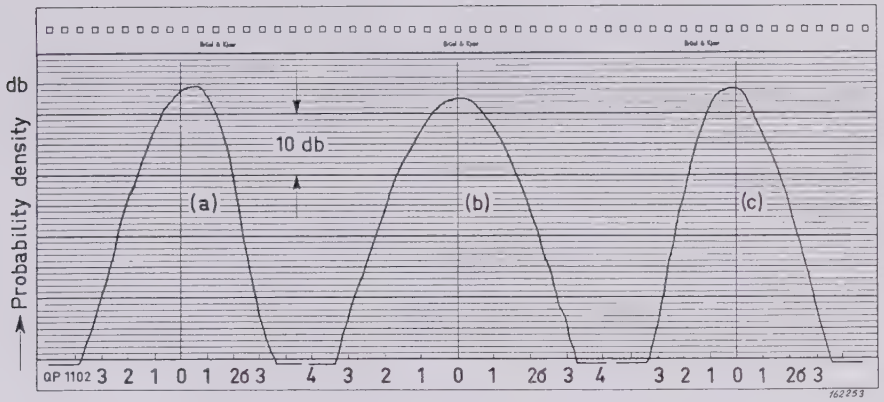


Fig. 2.10. Typical magnitude distribution of output signal. Measured by an arrangement including a photo-multiplier.) Note the logarithmic value of ordinate.*
(a) One noise diode in operation.
(b) Two noise diodes in operation.
(c) The other noise diode in operation.

signal would appear to be unsymmetrical. This is illustrated in Fig. 2.10a and c, where the amplitude distribution of the output signal has been measured with only one of the noise diodes in operation.
As seen from Fig. 1.10b a symmetrical distribution is achieved, when both diodes are in circuit.

Distortion.
In some applications a low distortion of the noise signal is important, especially when bands of noise are applied.
To give an un-ambiguous representation of the distortion factor, it is measured for sine-wave signals. From these measurements the distortion of the noise signal can then be judged in the individual cases. Typical and guaranteed maximum values are represented by curves in Fig. 2.11. Three curve-sets are given, one for unloaded output, measured at the ATTENUATOR OUTPUT, and two for the loaded condition measured at the terminals LOAD. The curve-set, valid for the unloaded Generator, is masured at 10 V r.m.s. sine-wave, i.e. amplitudes, below 14 V in a noise signal will be distorted respectively less or equal to the values given by the curve-set. The two curve-sets valid for the loaded Generator are measured at 1 Watt and 2 Watts respectively sine-wave r.m.s. power. This corresponds to instantaneous noise peak magnitudes of 2 and 4 Watts respectively.

$$\text{RMS power} = \frac{V^2 \text{ r.m.s.}}{R}; \qquad \text{Peak power} = \frac{(V \text{ r.m.s.} \sqrt{2})^2}{R}$$

From the "power" curves in Fig. 2.11 can be found the r.m.s. noise power allowable for a noise signal, with a particular crest factor f_c and mag-

*) Refer to the B & K Technical Review No. 2-1961 and No. 4-1959.

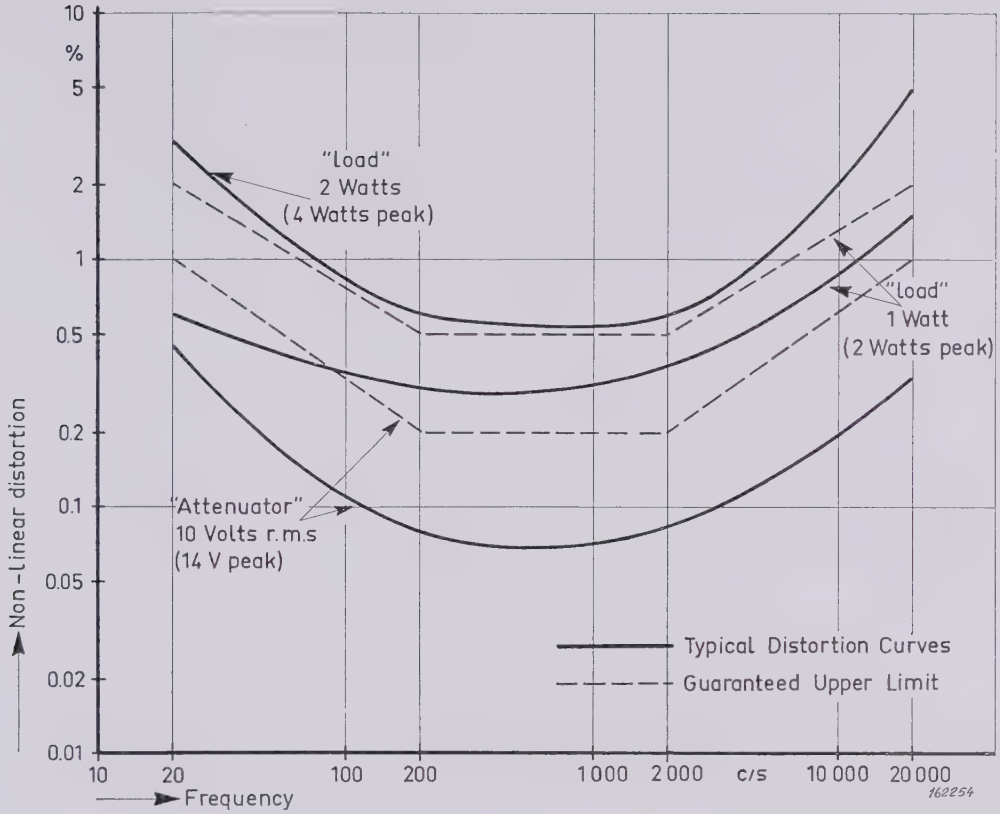


Fig. 2.11. Non-linear distortion as measured by sine-wave signals.

nitudes below $f_c\,\sigma$, of which has to be kept below a certain distortion. In other words, if the distortion of noise peak magnitudes of interest has to be below e.g. o.5 %, the instantaneous noise peak power of these should not be higher than the 2 Watts (1 Watt r.m.s.) for the middle frequencies, see Fig. 2.11. When, for example, a noise signal with crest factor $f_c = 4$ is wanted and the maximum magnitudes should not be more than o.5 % distorted, the noise power has to be less than:

$$\frac{W_{peak}}{(f_c)^2} = \frac{2}{4^2} = \text{o.125 Watt}$$

That the Noise Generator supply is below this, so derived noise power (o.125 W), can be calculated from the indicating meter deflection and the load resistance.

Clipping.

The noise peak amplitudes of significance in a practical source signal can be considered to be lower than four times the r.m.s. level. Such amplitudes are easily supplied from the Noise Generator, without clipping, at the maximum r.m.s. noise voltage (σ) of 40 V, as the maximum peak voltage is 170 V

$$4\,\sigma = 4 \times 40 = 160 \text{ V}$$

If for special purposes a noise signal with a crest factor higher than four is desired, this can be obtained by reducing the output voltage. The increase of the factor is inversely proportional to the indicating meter deflection. This means, that for example, at half deflection, noise amplitudes of approximately $8 \times \sigma$ will be present in the noise output signal.
In measurements where bands of noise are taken from the Noise Generator, i.e. a band filter is inserted between the input amplifier and the output amplifier, clipping is only perceptible from the output amplifier. This because clipped random noise is still random when afterwards filtered by a band filter displaying a bandwidth which is narrow compared to the bandwidth of the signal being clipped. Consequently, clipping of the signal in the input amplifier will under these circumstances not be perceptible.

Signal-Hum Ratio.
The signal-hum ratio of the Noise Generator means here the ratio: generated noise signal to hum, induced in the Generator from the line voltage. When the Noise Generator is in a linear condition (wide band) the signal-hum ratio will be better than 70 dB.

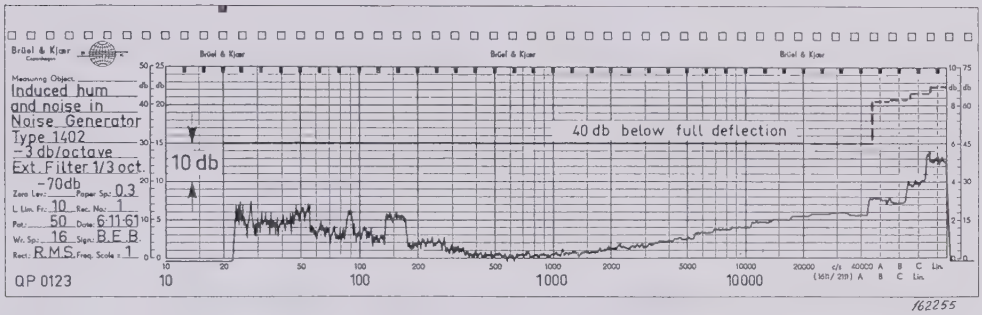


Fig. 2.12. Typical signal-noise ratio of the Noise Generator as measured on the output. Full indicating meter deflection is displayed but at — 40 dB below actual level. The Band-Pass Filter Type 1612 (1/3 octave) was inserted in the Noise Generator and the — 3 dB/octave weighting network switched in.

The ratio: generated noise signal to extraneous noise (inclusive hum) is illustrated in Fig. 2.12, which shows the way the ratio varies with frequency. For these measurements the —3 dB/octave weighting network was used, and the Band-Pass Filter Type 1612 (⅓ octave) was inserted. The result, measured in ⅓ octaves on the Generator output, is given in dB and related to full indicating meter deflection through the complete frequency range.
The signal-hum ratio and the curve in Fig. 2.12 is measured during short-circuiting of both noise diodes. The extraneous noise, excluding the hum voltage, has a statistical character and has therefore no influence on the magnitude distribution of the generated (wanted) noise. Theoretically, the part of this noise derived from the output amplifier can affect the frequency

response when filters, providing very narrow bands, are inserted in the Noise Generator.

Power Supply.

The power supply section is made up of the anode supply and two separate heater supplies. The various voltages are taken from three separate windings on the mains transformer. The primary of this transformer is provided with taps which means that the apparatus can be used on mains voltages of 100, 115, 127, 150, 220 or 240 V. The correct value is easily selected with a special selector on the rear of the apparatus. This selector is combined with the fuseholder which contains the fuse (medium lag) connected in circuit with the primary winding of the transformer. To operate the mains voltage selector, refer to the "Operation" section.
A two-pole switch marked POWER is inserted in the primary circuit of the mains transformer.

Anode Supply. The d.c. voltage for the anode supply is taken from a full-wave semiconductor rectifier via a smoothing filter. To obtain stable working of the Noise Generator even with mains voltage fluctuations of $\pm$ 10 %, the anode voltage is stabilized for the critical tubes in the circuit.

Heater Supply. To achieve a very low hum level at the output of the Noise Generator, the heaters of the tubes with low signal levels are d.c. supplied. This d.c. voltage is derived from a separate winding on the mains transformer, rectified in a full-wave semiconductor rectifier, and smoothed. The voltage for the built-in oscillator-stop relay is also supplied from this d.c. source.
The heater voltage for the remaining tubes and for the meter scale lamp is a.c. supplied from another transformer winding.

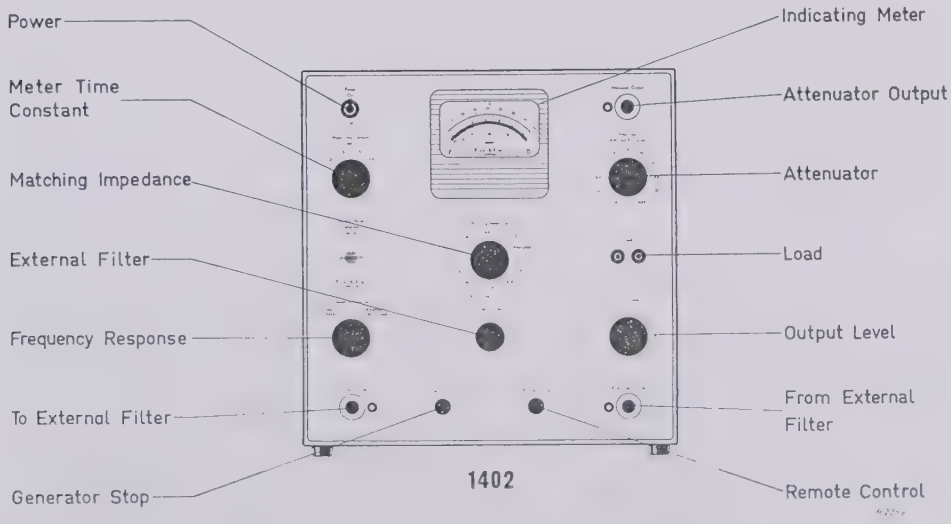


Fig. 2.13. Front view of Noise Generator.

3. Control Knobs and Terminals

POWER:

When switched to "On", the meter scale will be illuminated.

METER TIME CONSTANT:

For alteration of signal rectifier averaging time. The selectable values 0.5, 1.5, 5, and 15 sec. mean here the time it takes the meter pointer to fall, when disconnecting the signal, to ⅓ of the original deflection.

MATCHING IMPEDANCE:

6 Ω, 60 Ω, 600 Ω, or 6000 Ω load can be connected in the respective positions. The actual impedances are 10—20 % of the stated values.
The voltages indicated by MATCHING IMPEDANCE positions are the r.m.s. voltages obtainable for full meter scale deflection.
"Attenuator". The output voltage is available on the terminal ATTENUATOR OUTPUT and can be attenuated by the switch ATTENUATOR.

EXTERNAL FILTER:

"Out". Possible external filters connected to TO EXTERNAL FILTER and FROM EXERNAL FILTER are switched out of circuit. Simultaneously the input amplifier is connected to the output amplifier via a built-in resistive attenuator.
"In". External filters connected to TO EXTERNAL FILTER and FROM EXTERNAL FILTER are inserted between input amplifier and output amplifier.

FREQUENCY RESPONSE:

"Linear, 20—20000 c/s". The noise signal has uniform spectrum density.
"Weighted, —3 dB/octave". The noise signal is weighted as a function of frequency by —3 dB/octave.

TO EXTERNAL FILTER:

Intended for connection of external filters. The output signal from the input amplifier is available when EXTERNAL FILTER is in position "In".

GENERATOR STOP: Pushbutton for cutting off the output noise signal.

ATTENUATOR OUTPUT: Output signal available when MATCHING IMPEDANCE is in position "Attenuator". R.M.S. signal level is read on the indicating meter in accordance with the value indicated by the position on the ATTENUATOR switch.

ATTENUATOR: When MATCHING IMPEDANCE is set to "Attenuator", the output signal from ATTENUATOR OUTPUT can be attenuated in ten accurate steps of 10 dB. The values indicated by the knob positions correspond to the mV r.m.s. available at full-scale indicating meter deflection.

LOAD: Terminal set presenting various output impedances. Refer also to item MATCHING IMPEDANCE above. The right-hand terminal (without white dot) is grounded.

OUPUT LEVEL: Continuously variable linear potentiometer which attenuates the input signal to the output amplifier, thus affecting both the outputs LOAD and ATTENUATOR OUTPUT.

FROM EXTERNAL FILTER: Intended for connection of external filters. Signals can be applied to the input of the output amplifier when EXTERNAL FILTER is in position "In".

REMOTE CONTROL: Jack for connections in case the generator stop arrangement has to be remotely controlled.

4. Operation

General.

Adjusting to Proper Power Supply Voltage.

Check on the rear of the apparatus that the power supply voltage selector is set to the proper voltage. If not, remove the fuse, and turn the middle portion of the combined fuse holder and selector until the white mark rests opposite the proper voltage. Replace the fuse, and switch POWER to "On". The scale should immediately be illuminated, and after a period of a few minutes the apparatus is ready for use.

Setting up.

A. Wide Band Output Signal (Uniform Spectrum Density).

I. Set the control knobs as follows:
   1. FREQUENCY RESPONSE on "Linear", 20—20ooo c/s".
   2. METER TIME CONSTANT on "o.5".
   3. EXTERNAL FILTER on "Out".

II. Turn OUTPUT LEVEL so that a suitable deflection on the indicating meter is obtained.

III. Two output terminals can be employed:
   ATTENUATOR OUTPUT intended for high impedance loads (5ooo Ω or higher)
   LOAD intended for low impedance loads (6 Ω to 6ooo Ω)
   NOTE: The right terminal is grounded.
   1. ATTENUATOR OUTPUT:
      Set MATCHING IMPEDANCE in position "Attenuator" and adjust to the appropriate signal level with OUTPUT LEVEL potentiometer and ATTENUATOR.
   2. LOAD:
      Set MATCHING IMPEDANCE to a value as near as possible to that of the load impedance, and adjust to appropriate signal level with OUTPUT LEVEL potentiometer.

B. Wide Band Output Signal (— 3 dB/Octave Weighted).

I. Set the control knobs as follows:
   1. FREQUENCY RESPONSE on "Weighted, — 3 dB/Octave".
   2. METER TIME CONSTANT on "5".
   3. EXTERNAL FILTER on "Out".

   Then continue, following section A, item II and III above.

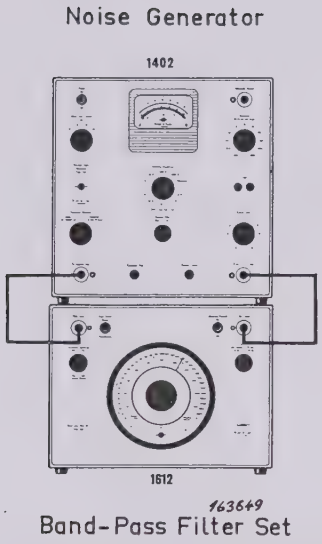


Fig. 4.1. Combined Noise Generator and Band-Pass Filter Set Type 1612.

C. Narrow Bands Output Signal (Constant Output Voltage Versus Frequency).

I. Connect the B & K Band-Pass Filter Set Type 1612 as illustrated in Fig. 4.1.

II. Set the control knobs on the Filter Set as follows:
   1. INPUT SWITCH on "Direct".
   2. WEIGHTING NETWORK to "Off".
   3. FUNCTION SELECTOR to "1/3 Octave" or "Octave" as desired. Choose the desired noise band with the FILTER SELECTOR.

III. Set the control knobs on the Noise Generator as follows:
   1. METER TIME CONSTANT is set to a position where a stable deflection of the indicating meter pointer is achieved.
      NOTE: Using a high meter-time-constant value, the METER TIME CONSTANT may first be set to a low value and then to the position required. In this manner a faster reading is obtained.
   2. EXTERNAL FILTER on "In".
   3. FREQUENCY RESPONSE on "Weighted, — 3 dB/octave".

IV. Then continue as stated in section A, "Wide Band Output Signal", item II and III.

5. Accessories

Band-Pass Filter Set Type 1612

Bands of noise can be supplied from the Noise Generator, when the Band-Pass Filter Set Type 1612 is inserted between the amplifier sections via the two EXTERNAL FILTER terminals of the Noise Generator. By using this combination, Noise Generator plus Band-Pass Filter, the characteristic of the noise signal fulfils, among other things, the requirements included in the ISO Recommandation for "Measurements of Absorption Coefficients in a

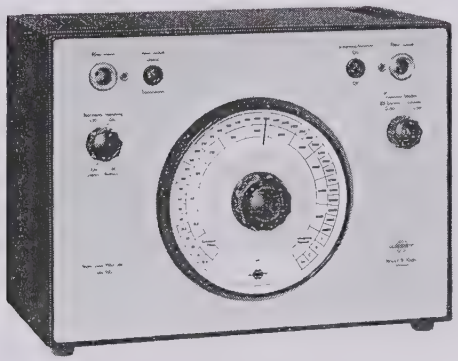


Fig. 5.1. Band-Pass Filter Set Type 1612.

Reverberation Room" and "Field and Laboratory Measurements of Airborne and Impact Sound Transmission".

The Filter Set consists of filters of 1/3 and 1/1 octave bandwidth covering the frequency range 22 to 45000 Hz (c/s). The filters display high selectivity and flat pass band. (Refer to Figs. 5.2 and 5.3). They are manufactured with such a uniformity that the noise output voltage from the Filter Set deviates less than ± 0.4 dB from the theoretical 10 dB/decade (3 dB/octave) line, when the 1/3 octave filters are selected. If lower frequency bands than 22 Hz (c/s) are desired, an Extension Filter Set Type 1620 can be combined with the Band-Pass Filter Set Type 1612. With this combination noise bands of 1/3 and 1/1 octave can be selected from 11 Hz (c/s to 35000 Hz (c/s).*)

The Filter Set also includes four different weighting networks, which, however, should be switched out of circuit when the Filter Set is used to select noise bands from the Noise Generator. Three of them are intended for sound level measurements and fulfil the proposed I.E.C. requirements for

*) The highest frequency is limited by the Noise Generator.

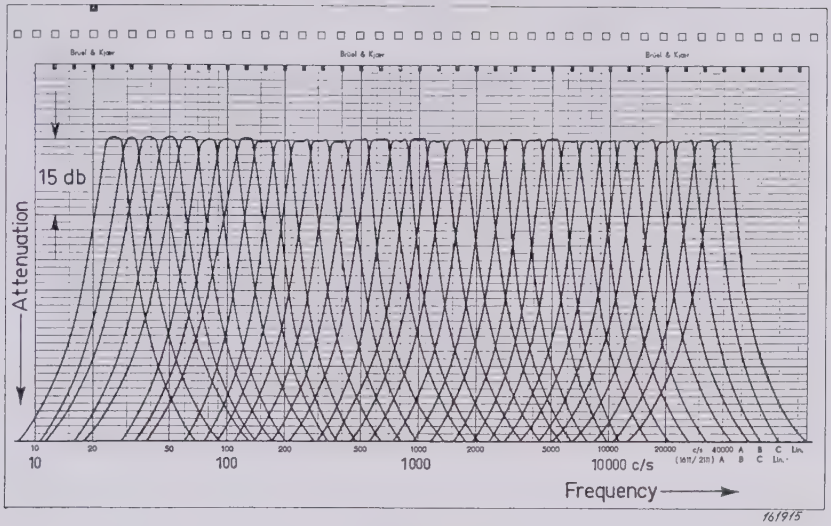


Fig. 5.2. Complete set 1/3 octave filter characteristics of Band-Pass Filter Set Type 1612.

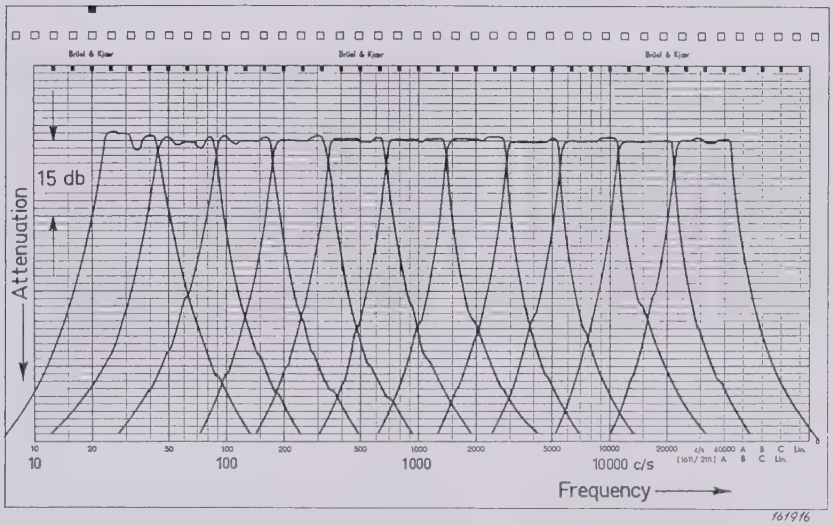


Fig. 5.3. Complete set 1/1 octave filter characteristics of Band-Pass Filter Set Type 1612.

Precision Sound Level Meters. The fourth network gives a linear characteristic from 20—45000 Hz (c/s).

The filters can be selected manually or remotely. The latter method may, for example, be used when the combined Noise Generator and Filter Sets are used together with the B & K Level Recorder Type 2305. By such arrangement bands of noise can be automatically selected in synchronism with the preprint on the recording paper, whereby various characteristics can be recorded versus frequency. Vide Fig. 2.9. The Noise Generator can be conveniently placed on top of the Filter Set Type 1612.

SPECIFICATION

Frequency Range:	22—45ooo Hz (c/s).
Band-Pass Filters:	Centre frequencies, in accordance with ISO standard, 1/3 octave, 25—40ooo Hz (c/s), 1/1 octave, 31.5—31500 Hz (c/s). Selectivity, 1/3 octave filters, approximately 50 dB at 1 octave from centre frequency 1/1 octave filters, approximately 35 dB at 1 octave from centre frequency Deviation in pass-band, within ± o.5 dB for 1/3 octave filters ± 1 dB for 1/1 octave filters, ± 2 dB for 31.5 and 63 c/s octave filters Deviation from teoretical 10 db/decade line, within ± o.4 dB for noise with uniform spectrum density.
Weighting Networks:	"A", "B", "C" according to the proposed IEC Standards for Precision Sound Level Meters (Helsinki 1961). "Lin." gives linear range 20—45ooo c/s. Cutting-off below 20 Hz (c/s) to a slope of approximately 18 dB per octave.
Distortion:	Lower than o.1 %.
Rotary Switch for Selection of Filters:	Manually or remotely controlled.

Balancing Output Transformer Type TU 0005.

In measurements on symmetrical circuits, such as telephone circuits, balanced amplifiers, etc. the Balancing Output Transformer Type TU 0005 can be

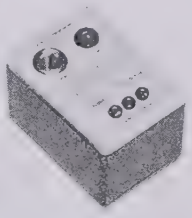


Fig. 5.4. Balancing Output Transformer TU 0005.

inserted between the ATTENUATOR OUTPUT of the Noise Generator and the object under measurement. The Transformer transfers the asymmetrical output of the Noise Generator into a symmetrical output of 600 Ω. Special efforts are made to ensure high electrostatic and electromagnetic shielding as well as low distortion.

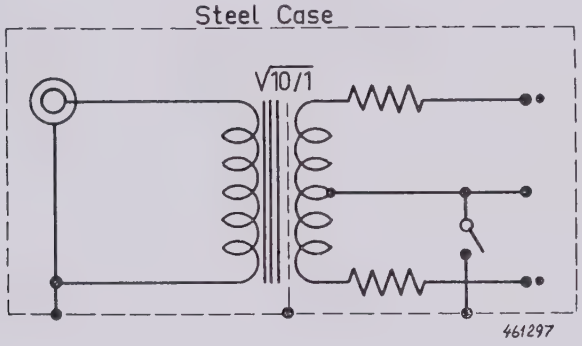


Fig. 5.5. Diagram of Balancing Transformer.

SPECIFICATION

Frequency Response:	20—35000 Hz (c/s) within ± 0.2 dB.
Voltage Ratio: (primary/secondary)	Unloaded; $\sqrt{10} : 1 \sim -10$ dB Loaded with 600 Ω; $2\sqrt{10} : 1 \sim -16$ dB.
Symmetry:	Better than 0.1 %, 20 Hz (c/s to 35 kHz (kc/s)
Distortion:	Less than 0.2 % from 300 Hz (c/s) to 35 kHz (kc/s) Less than 0.5 % from 20 Hz (c/s) to 35 kHz (kc/s)
Output Impedance:	600 Ω ± 1 %
Maximum Input Voltage:	12.5 V r.m.s. sine-wave (18 V peak)

6. Applications

Various forms of noise are excellent sources for acoustical measurement purposes as well as for mechanical reliability testing.

When used as a sound source in room-acoustic measurements, such as reverberation time, sound distribution and sound insulation investigations, the continuous frequency spectrum is an advantage as all room resonances inside a certain frequency band are simultaneously exited. The similarity in magnitude distribution between random noise and "natural sounds" also ensures that the resonances are excited in a way similar to that occuring in the room under every day conditions. In the field of mechanical reliability testing the electrical noise is normally by means of electrodynamic vibrators converted into what is known as "random vibrations". These Random vibrations are then applied to the test specimen which may range from complete structures to small compact component assembles. Again the continuous frequency spectrum and statistical magnitude distribution allow for a better simulation of many "natural" vibration environments, like road and air-transportation, than does for instance a sinewave type vibration. Finally, random noise may be used in scientific model experiments for a wide variety of purposes.

In the following some typical examples of application of the Random Noise Generator Type 1402 are described.

Measurement of Reverberation Time.

An arrangement which is well-suited for automatic sound reverberation measurements is shown in Fig. 6.1. The Noise Generator combined with the B & K Band-Pass Filter Set Type 1612 and one or more loudspeakers, constitute the transmitting part. By using the Band-Pass Filter Set Type 1612, the output power from the Noise Generator can be concentrated in 1/3 octave or 1/1 octave bands. This ensures a higher dynamic range when the receiving part of the equipment measures in narrow bands i.e. when the reverberation time is measured as a function of frequency. If there is perceptible background noise, a power amplifier may also be necessary to ensure a sufficient dynamic range for the decays. The receiving part is made up of a B & K Condenser Microphone (in this case the Type 4134 with associated Cathode Follower Type 2615), the A.F. Spectrometer Type 2112, and the Level Recorder Type 2305. The A.F. Spectrometer allows the decays to be measured (recorded) for each 1/3 or 1/1 octave in the frequency range of the Noise Generator.

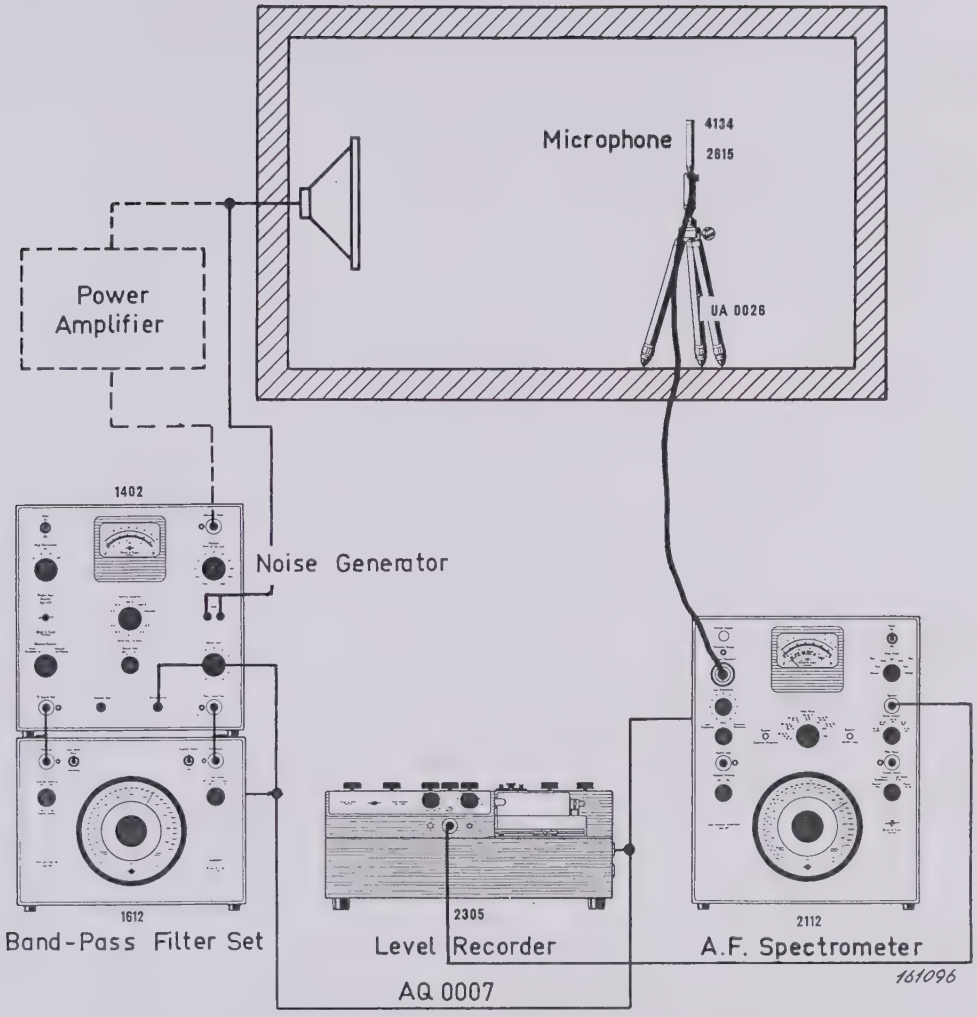


Fig. 6.1. Measuring arrangement used for automatic recording of reverberation decay curves.

The complete arrangement can be set to work automatically when the REMOTE CONTROL sockets of the instruments 1612, 2112, 2305 and 1402 are connected as shown in Fig. 6.2. The automatic method can be conveniently applied in the investigation of large rooms and for absorption of large measurements in laboratory reverberation rooms. A great asset, which is also afforded by the automatic method, is that the decay curves in the desired frequency range will be spaced by 1/3 octave on a short recording chart, see Fig. 6.3.

When few decays only have to be measured, the connection for automatic operation should be omitted. The decays are then recorded by operating the

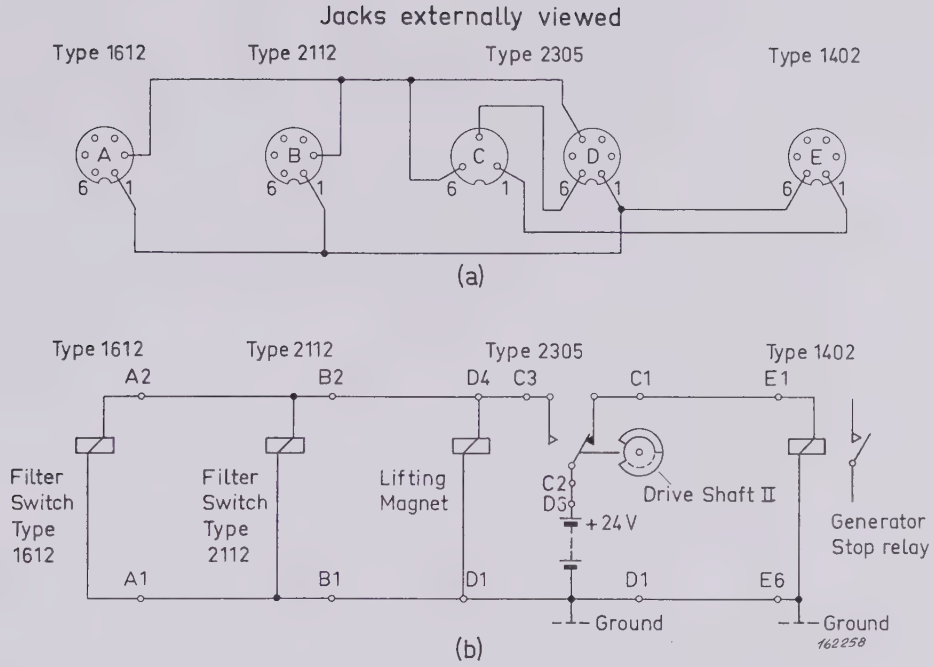


Fig. 6.2. Connection of the instruments remote control plugs for automatic recording of reverberation curves.

a) Schematic diagram of wiring between the various plugs.
b) Interconnections of remote control circuits of the instruments included in a reverberation time measuring arrangement.

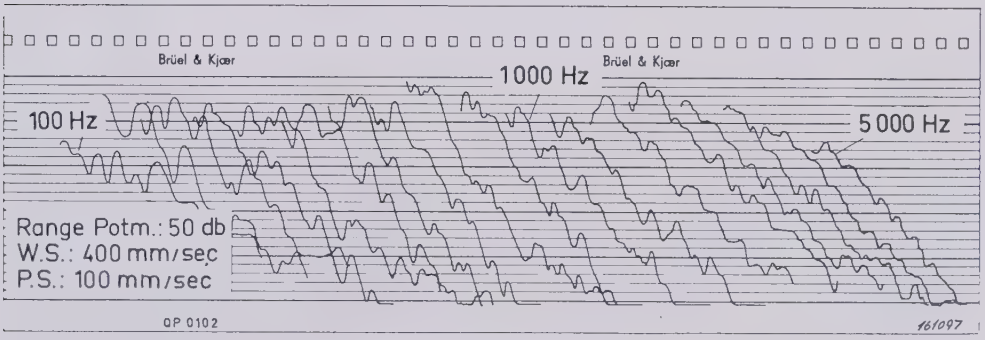


Fig. 6.3. Reverberation decay curves recorded automatically with the equipment shown in Fig. 6.1. The curves are spaced by intervals of 1/3 octave.

pushbutton GENERATOR STOP on the Noise Generator. The Spectrometer (and Band-Pass Filter Set, in cases where this is used) is successively set to the desired frequencies during the measurement. A decay curve obtained in this way is reproduced in Fig. 6.4.

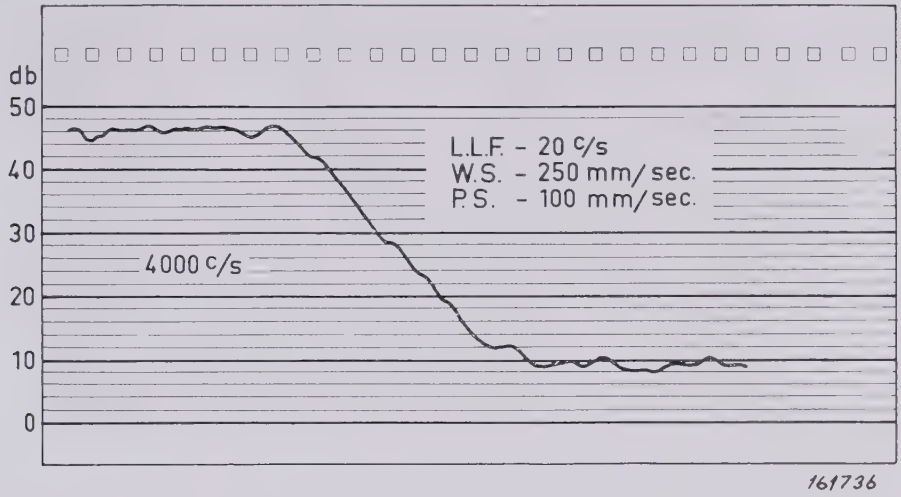


Fig. 6.4. Reverberation decay curve recorded with equipment illustrated in Fig. 6.1.

Measurement of Airborne Sound Insulation.

When measuring the sound insulation of a partition between two rooms an arrangement as illustrated in Fig. 6.5 can be used. The output signal from the Noise Generator Type 1402 is applied to the loudspeakers in the "transmitter" room via a power amplifier. A power amplifier may be necessary to produce a sufficiently high sound pressure level in rooms with perceptible background noise. The receiving equipment consists of a B & K Condenser Microphone (here the Type 4134 is used), the A.F. Spectrometer Type 2112 and the Level Recorder Type 2305. With the Spectrometer the signal from the Microphone can be measured in bands of 1/3 or 1/1 octaves. The Level Recorder records the analyzed signal automatically on preprinted frequency calibrated charts. From the difference in dB between the sound pressure levels measured in the transmitter room and receiver room the insulation property of the partition can be calculated provided adequate correction is made for the absorption in the receiver room. From the recorded curves in Fig. 6.6, the difference in sound pressure levels can be read in dB from the recorded chart.

Measurement of Sound Distribution.

In the determination of the sound distribution in concert halls, radio and television studios, churches etc. the Random Noise Generator is also an excellent sound source. Below is illustrated a simple measurement carried out in a church. The instrumentation was as illustrated in Fig. 6.7. By means of the B & K Precision Sound Level Meter Type 2203 the sound level radiated from the loudspeaker at the pulpit was measured in various places. In Fig. 6.8 is shown a groundfloor plan of the church, where the measured sound levels are marked in.

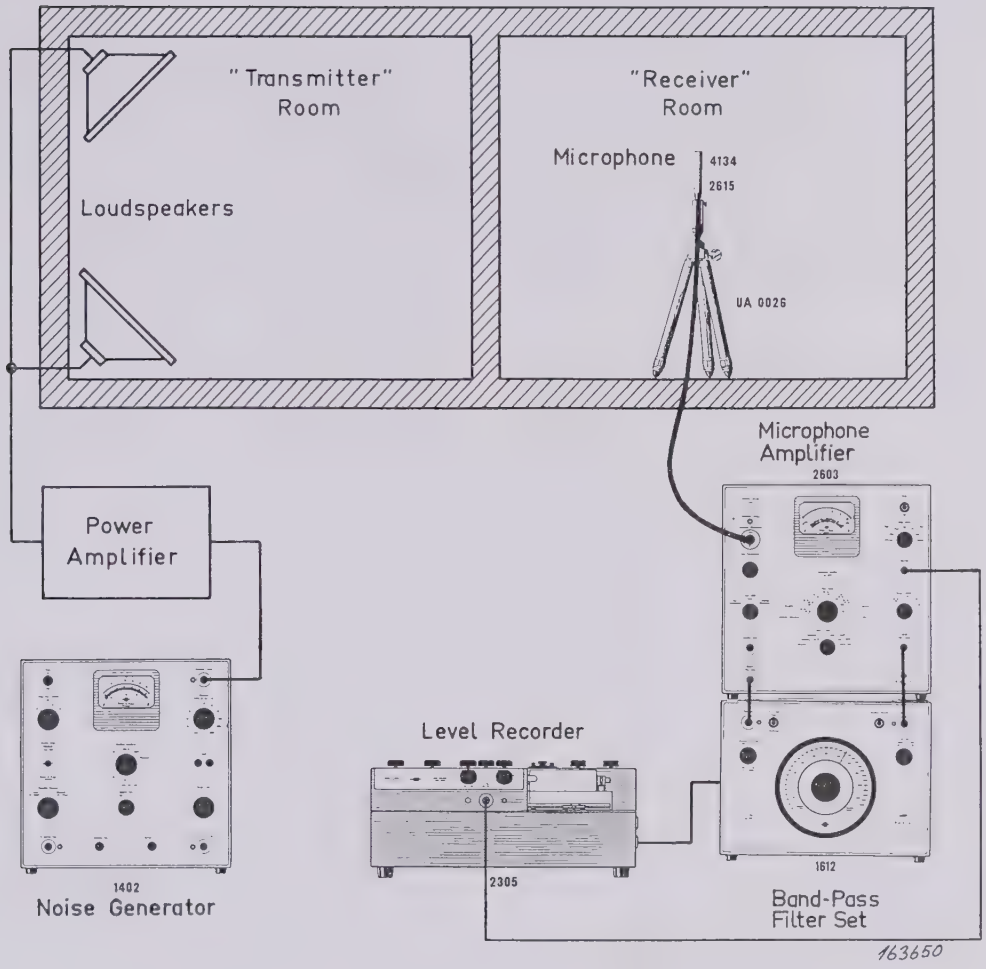


Fig. 6.5. Sound insulation measuring arrangement.

Random Vibration Testing.

Vibration tests are carried out on automobiles, aircraft, missiles and components which are intended to operate in a vibrational environment. The specimen to be tested is normally mounted on an electrodynamic shaker which is driven from an electronic signal source via a power amplifier, see Fig. 6.9. The signal source may consist of a more or less specialized sine wave generator or of a noise generator. The noise generator is then capable of producing random vibration on the shaker table. Its frequency characteristic may be shaped in various ways partly to compensate for shaker/specimen resonances, and partly for the production of any desired vibration spectrum. Investigations as to the functioning of the test specimen in a random vibration environment can then be carried out over short or lengthy periods of time.

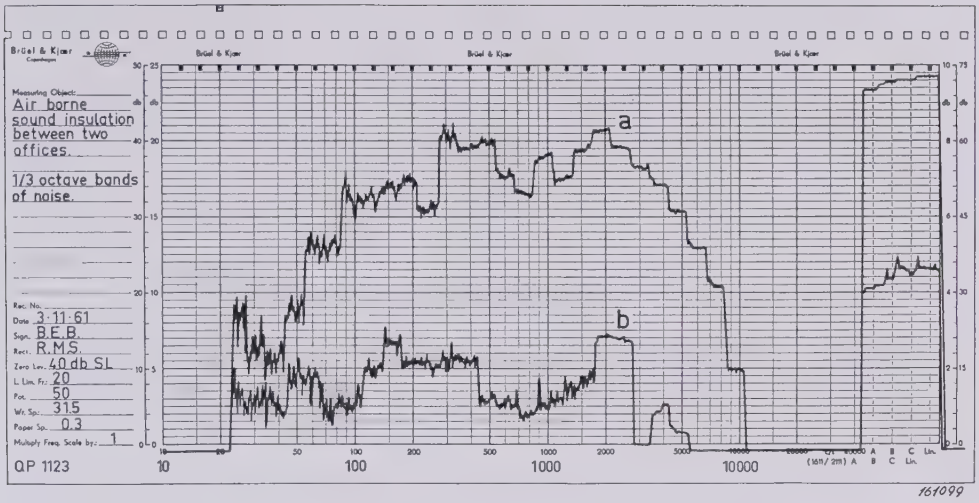


Fig. 6.6. Recorded sound pressure level versus frequency. The curves are recorded successively.

a) "Transmitter" room.
b) "Receiver" room.

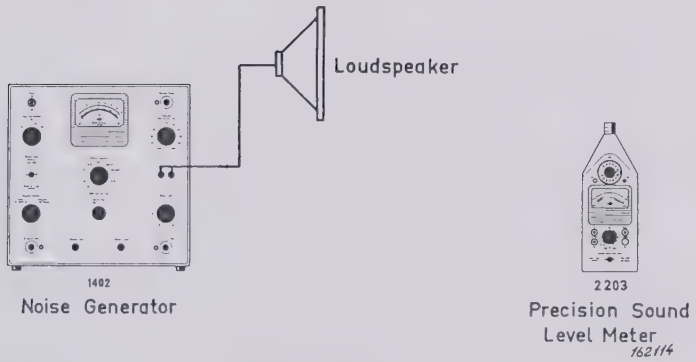


Fig. 6.7. Instrumentation for measuring sound distribution.

Measurements on Communication Systems.

Also in the audio electronics field the use of random noise is often convenient. In telecommunications for instance, the Noise Generator can be used in cross-talk measurements and for the determination of the necessary signal-to-noise ratio on communication lines. In this type of measurements a balanced output with a specified impedance is usually required for this purposes the B & K balanced Ousput Transformer Type TU 0005 can be used.

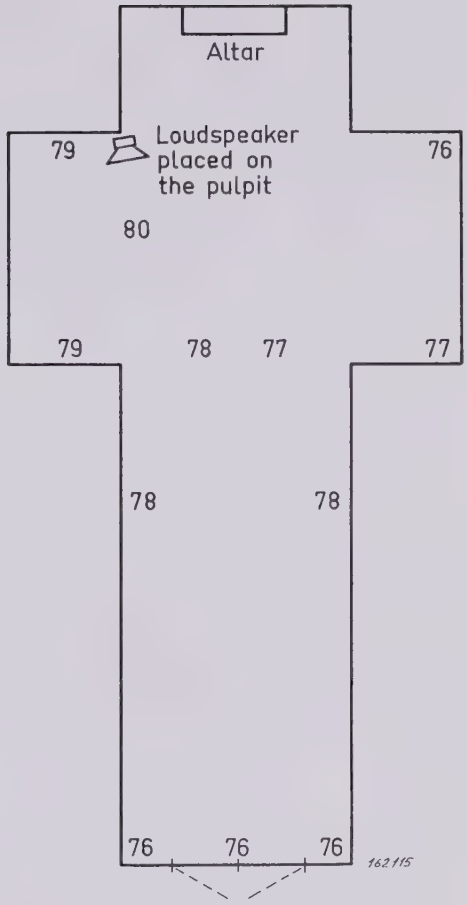


Fig. 6.8. Sound distribution in a church (without attendance). The figures are the sound pressure levels measured in dB re. 2×15^{4} μbar.

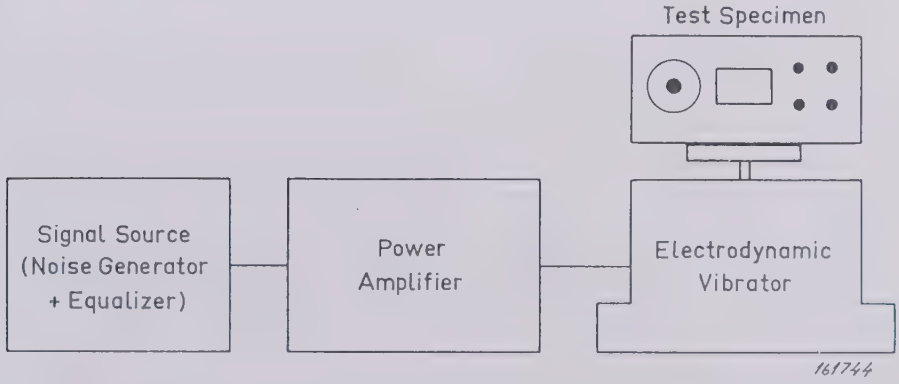


Fig. 6.9. Basic arrangement for random vibration testing using an electrodynamic vibrator.

Statistical Model Measurements.

A special field of application for the Type 1402 Random Noise Generator is the field of statistical model experiments. Due to its true Gaussian instantaneous magnitude distribution up to some 4 σ the signal from the Noise Generator is especially well suited for this kind of measurements. In Fig. 6.10 for instance is shown a measuring arrangement used to determine the statistical distributions of the output signal from an electro-mechanical analogue model excited by Gaussian random noise. The "Special Electronic Counter" shown in the figure can be connected to measure the probability density of the instantaneous as well as the peak values of the signal from the "Test Circuit". If the test circuit is linear only the peak value measurement will be of interest, and in Fig. 6.11 the result of peak probability density measurements on a three degrees-of-freedom electrical model is shown.

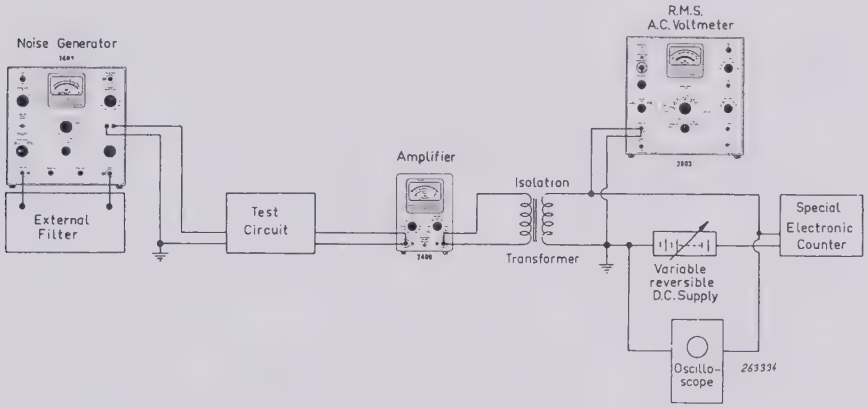
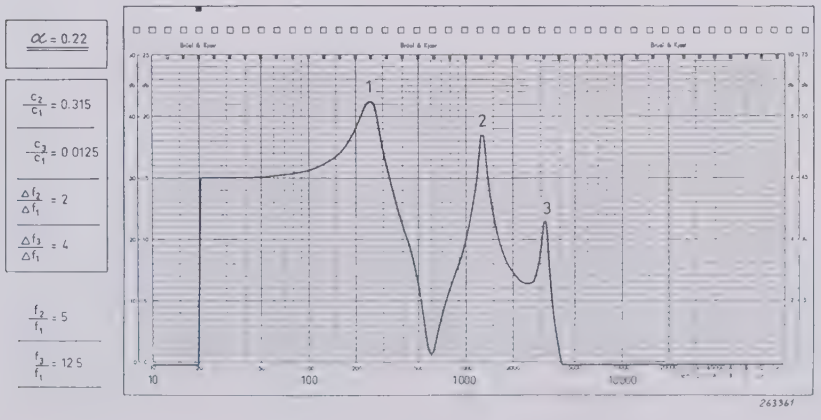
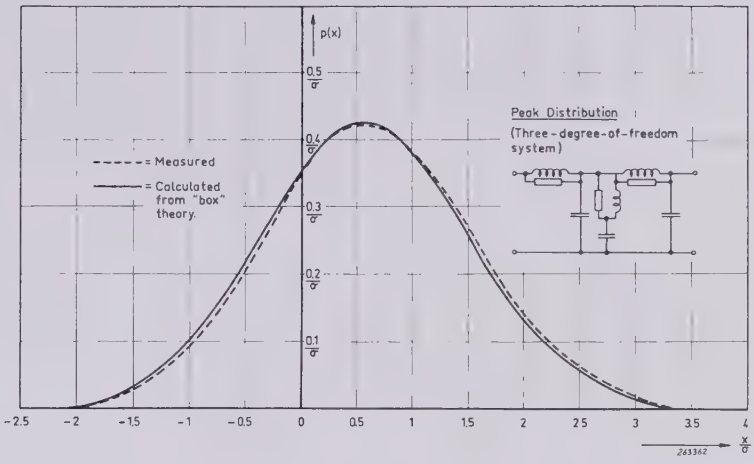


Fig. 6.10. Measuring arrangement used to determine experimentally the statistical properties of the output signal from an electro-mechanical model.



a.



b.

Fig. 6.11. Frequency response, peak probability density curve and electrical analogue circuit for a three degrees-of-freedom system excited by wide band "white" noise.

a. Frequency Response.
b. Peak probability density curve and analogue circuit.

7. Specification

Output Signal Characteristics:

The Generator can be switched to show:

(1) Uniform spectrum density in the frequency range 20—20000 Hz (c/s).
Within ± 0.5 dB on ATTENUATOR OUTPUT or open-circuited output on LOAD.
Within ± 1 dB at maximum output power from LOAD.

(2) 3 dB/octave decreasing spectrum density in the frequency range 20—20000 Hz (c/s).
Within ± 1 dB on ATTENUATOR OUTPUT or open-circuit output on LOAD.
Within ± 1.5 dB at maximum output power from LOAD.

(3) 1/3 and 1/1 octave bands of noise with constant r.m.s. voltage in the frequency range 11—35000 Hz (c/s). When the Noise Generator is combined with the B & K Band-Pass Filter Set Type 1612 and Extension Filter Set Type 1620.
In frequency range 20—20000 Hz (c/s), accuracy as in (2).
In frequency range 11—35000 Hz (c/s) within ± 3 dB on ATTENUATOR OUTPUT or open circuit output on LOAD.

Amplitude Distribution: Random, Symmetrical Gaussian (normal) within at least $4 \times$ r.m.s. value ($4 \times \sigma$) at full indicating meter deflection. Higher crest factors than 4 when below full deflection.

Output Signal Levels: Variable in steps of 10 dB and continuous within each step.

ATTENUATOR OUTPUT: 40 μV to 4 V. r.m.s. (full scale deflection) in 10 steps. Accuracy ± 0.2 dB in relation to position "4000".

LOAD Output: 1.2 V to 40 V. r.m.s. (full scale deflection) in 3 steps. Maximum output power 0.25 watt (instantaneously 4 watt at the peak noise magnitudes.)

ATTENUATOR OUTPUT:

Output Impedance: 50 Ω approx.

LOAD Output:

Matching Impedance: 6, 60, 600, and 6000 Ω selectable by the switch MATCHING IMPEDANCE (the respective output impedances are approximately 10—20 per cent of indicated values.)

Signal/Hum Ratio: Better than 70 dB at full indicating meter deflection and wide band. Better than 55 dB for a 1/3 octave noise band covering the mains frequency and its harmonics.

Non-Linear Distortion:*) Maximum sine-wave distortion for complete Noise Generator:

Frequency	20 Hz (c/s)	200 Hz (c/s)	2 kHz (kc/s)	20 kHz (kc/s)
ATTENUATOR OUTPUT open circuit, at 10 V r.m.s. from output amplifier	1 %	0.2 %	0.2 %	1 %
LOAD, output 1 watt	2 %	0.5 %	0.5 %	2 %

Terminal TO EXTERNAL FILTER:

Output Voltage: 2 V r.m.s. noise signal.

Output Impedance: 10 Ω approximately. Maximum DC load 75 kΩ.

TERMINAL FROM EXTERNAL FILTER:

Input Resistance: 150 kΩ approx.

Built-in Vacuum-Tube Voltmeter:

Frequency Response: Within ± 0.2 dB in the range 20—20000 Hz (c/s).

Voltmeter Attenuator:**) Within ± 0.1 dB in relation to position "4 V, 60 Ω"

Rectifier Circuit: R.M.S. detection of Gaussian random noise and sine-wave signals.
Relative deviation in random noise and sine-wave reading, within ± 0.2 dB for scale deflection higher than 0 dB.

Indicating Meter: Moving coil, perfectly protected against overload. Accuracy: 1 % of full deflection.

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*) Mainly determined by the output amplifier, see also Description, page 17.

**) Combined with MATCHING IMPEDANCE switch.

Meter Time Constant: 0.5, 1.5, 5, and 15 sec. selectable by switch. (For definition of the constant, vide Description).

Stability: The sensitivity of the built-in Vacuum-Tube Voltmeter will change less than ± 1 % for ± 10 % deviation in power supply voltage.

Remote Control: Means for remote control of Generator Stop by a make contact.

Tubes: 1 × ECC81 (12AT7), 3 × ECC82 (12AU7), 2×ECC83 (12AX7), 1 × EF94 (6AU6), 1 × EL84 (6BQ5).

Power Supply: 100 — 115 — 127 — 150 — 220 — 240 V AC, 50—400 Hz (c/s).
Consumption 65 W approx.

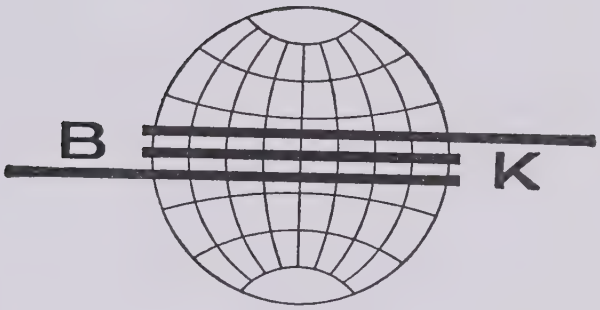
Weight:

Model	kgs.	lbs.
A	13.5	29¾
B	17.5	38½
C	17.1	37½

Dimensions:

Model	Height	Width	Depth
A	38 cm 15″	38 cm 15″	20 cm 8″
B	40.5 cm 17¾″	40.5 cm 17¾″	21—27.3 cm 8½″—10¾″
C	Suitable for Standard 19″ rack mounting		

Accessories Included:
1 power cord
3 coaxial plugs (JP 0018)
1 six-pin plug (JP 4705) for REMOTE CONTROL jack
Spare fuses and lamps



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January 1965

MARCH 1965
Valid from Serial no. 138.507

Parts-List

Random Noise Generator

Type 1402

S/N. 159711

Brüel & Kjær

DENMARK

PARTS-LIST 1402

Component Type		Stock Reference	Circuit-diagram Reference
Power cable, EUR		AN 0005	
Power cable, USA		AN 0006	
Capacitors:			
Electrolytic	2×24 μF/350 V	CE 6896	C 1, 2
»	8 μF/320 V	CE 0802	C 3
»	2×48 μF/450 V	CE 2269	C 4, 5
»	50 μF/450 V	CE 0901	C 6
»	2×100 μF/350 V	CE 2989	C 7, 8, 11
»	2×100 μF/450 V	CE 0902	C 9, 10
»	2×1000 μF/25 V	CE 0402	C 13, 14
«	1000 μF/100 V	CE 0501	C 15
»	16 μF/450 V	CE 6846	C 16
»	100 μF/12 V	CE 8946	C 12, 17
Ceramic	4.7 pF/500 V	CK 0470	C 61
Paper	3.5 μF/250 V	CP 0342	C 18, 19
Polyester	22 nF/125 V	CS 0005	C 21
»	68 nF/125 V	CS 0011	C 22, 23
»	0.33 μF/125 V	CS 0019	C 24
»	1 μF/125 V	CS 0025	C 25-27
»	4.7 nF/400 V	CS 0122	C 28
»	47 nF/400 V	CS 0109	C 37
»	0.1 μF/400 V	CS 0113	C 29-31, 34
»	0.22 μF/400 V	CS 0117	C 32
»	0.47 μF/400 V	CS 0121	C 32
»	7 + 2 μF/200 V	CS 0600	C 35, 36
Polystyrene	300 pF/500 V	CT 0109	C 47
»	500 pF ± 5 %/500 V	CT 0113	C 40
»	10 nF $\begin{matrix}+0\\-2\end{matrix}$ %/200 V	CT 3331	C 41
»	31.6 nF $\begin{matrix}+0\\-2\end{matrix}$ % »	CT 3334	C 42, 43
»	100 nF $\begin{matrix}+0\\-2\end{matrix}$ % »	CT 3359	C 44, 45
»	200 nF $\begin{matrix}+0\\-2\end{matrix}$ % »	CT 3339	C 46
Trimmer, ceramic		CV 0017	C 51
Trimmer, ceramic		CV 0113	C 52
Miscellaneous:			
Front plate		FA 1402	
Meter		IM 1024	
Relay socket		JJ 0012	
Coaxial jack		JJ 0013	
Remote control socket 6' pole		JJ 4704	

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PARTS-LIST 1402

Component Type	Stock Reference	Circuit-diagram Reference
Terminal	JK 6272	
Coaxial plug	JP 0018	
Remote control input plug 6' pole	JP 4705	
Bushing for ground	JT 6204	
Cabinet wood	KA 0011	
Plastic cover	KF 0027	
Cabinet metal	KQ 0011	
Choke coil	LJ 0003	L 1
Choke coil	LJ 0004	L 2
Power switch	NN 0563	N 1
Push-button switch	NT 1775	N 2
Power Voltage selector	OA 0017	O 1
Relay	OC 0006	O 2
Matching Impedance switch	OR 1012	O 3
Attenuator switch	OT 1012	O 4
Meter Time Constant	OR 1402	O 5
Ext. Filter switch	OS 1402	O 6
Frequency Response switch	OT 1402	O 7
Trimmer potentiometer 1 kΩ	PG 2100	P 1
» » 5 kΩ	PG 2500	P 2
» » 10 kΩ	PG 3102	P 3
» » 500 kΩ	PG 4501	P 4
Potentiometer 100 kΩ	PP 4108	P 5
Selenium rectifier	QV 0005	Q 1
Silicon diode	QV 0022	Q 2, 3
Zener diode	QV 1306	Q 4
Noise diode (9051)	QV 0083	Q 5, 6
Noise diode (ZS17R)	QV 0092	Q 5, 6
Silicon power rectifier	QV 0025	Q 7, 8
Resistors:		
Carbon film ½ W	RK 4.62 kΩ ± 0.5 %	R 1
» » »	RK 10 kΩ » »	R 2
» » »	RK 31.6 kΩ » »	R 3
» » »	RK 100 kΩ » »	R 4
» » »	RK 170.28 Ω » »	R 5
» » »	RK 1.44 kΩ » »	R 6
» » »	RK 3.53 kΩ » »	R 7
» » »	RK 6.023 kΩ » »	R 8
» » »	RK 12.279 kΩ » »	R 9
» » »	RK 15.086 kΩ » »	R 10
» » »	RK 25 kΩ » 1 %	R 30, 31
» » »	RK 200 kΩ » »	R 39
» » ⅓ W	RK 31.5 kΩ » »	R 74, 75
» » »	RK 50 kΩ » »	R 76

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PARTS-LIST 1402

Component Type	Stock Reference			Circuit-diagram Reference
Carbon film ⅓ W	RK 63	kΩ	» »	R 77
» » »	RK 100	kΩ	» »	R 81
» » »	RK 33.4	kΩ	» 2 %	R 70
» » »	RK 1	MΩ	» »	R 84
Carbon film ½ W	RK 50	Ω		R 21
» » »	RK 56	Ω		R 22
» » »	RK 160	Ω		R 23
» » »	RK 200	Ω		R 24
» » »	RK 1	kΩ		R 25
» » »	RK 1.25	kΩ		R 26
» » »	RK 2	kΩ		R 27, 28
» » »	RK 2.5	kΩ		R 29
» » »	RK 10	kΩ		R 46
» » »	RK 25	kΩ		R 32
» » »	RK 31.5	kΩ		R 33
» » »	RK 50	kΩ		R 34-36
» » »	RK 63	kΩ		R 37
» » »	RK 100	kΩ		R 38
» » »	RK 200	kΩ		R 40
» » »	RK 250	kΩ		R 45
» » »	RK 315	kΩ		R 41-43
» » »	RK 400	kΩ		R 44
» » »	RK 2	MΩ		R 47
» » »	RK 3.15	MΩ		R 48
» » »	RK 10	MΩ		R 49, 50
» » 1 W	RK 63	kΩ		R 17
» » ⅓ W	RK 1	kΩ		R 60, 62
» » »	RK 1.6	kΩ		R 63-65
» » »	RK 2	kΩ		R 66, 67
» » »	RK 31.5	kΩ		R 71-73
» » »	RK 45	kΩ		R 61
» » »	RK 100	kΩ		R 78, 79
» » »	RK 500	kΩ		R 82-83
» » »	RK 1	MΩ		R 85, 87, 88
» » »	RK 2	MΩ		R 89
VDR	RL 0001			R 90
Wire-wound 3 W 600 Ω	RO 0121			R 91
» » 5 W 1500 Ω	RO 0217			R 92, 93
» » 5 W 25 Ω	RO 0303			R 94
» » 1 W 68.3 Ω ± 0.5 %	RO 0001			R 101
» » 1 W 100 Ω ± 0.5 %	RO 0002			R 102-110
» » 1 W 147.8 Ω ± 0.5 %	RO 0003			R 111-120
» » 5½ W 390 Ω	RX 0301			R 130
» » » W 6.2 kΩ	RX 0303			R 131
» » » W 15 kΩ	RX 0304			R 132

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